

WHAT IS CLAIMED IS:

1. An assembly for cleaning a thin, flat substrate, the assembly comprising:  
a support for engaging a thin, flat substrate, the substrate having at least a first surface;  
a liquid engaging the first surface;  
at least a first source of sonic energy; and  
at least a first sonic energy transmitter spaced from the substrate but in contact with the liquid; wherein  
the first source applies sonic energy to the transmitter, and the transmitter transmits the sonic energy to the substrate first surface through the liquid, and the transmitter attenuates the sonic energy to reduce the number of sonic waves that strike the substrate at or near a ninety-degree angle.
2. The assembly of Claim 1, wherein the support engages a periphery of the substrate.
3. The assembly of Claim 1, wherein the support supports the substrate in a substantially horizontal orientation.
4. The assembly of Claim 1, wherein the support is rotatable.
5. The assembly of Claim 1, further comprising a first source of liquid, wherein the first source of liquid applies the liquid to the substrate first surface.
6. The assembly of Claim 1, wherein the first source of liquid is a sprayer.
7. The assembly of Claim 1, wherein the first source of sonic energy comprises a transducer.
8. The assembly of Claim 7, wherein the transducer is coupled to the transmitter.
9. The assembly of Claim 1, wherein the first sonic energy transmitter comprises an elongate probe.
10. The assembly of Claim 9, wherein the probe extends generally parallel to the substrate first surface.
11. The assembly of Claim 9, wherein a portion of the probe directly adjacent to the substrate is configured to reduce a ratio of normal-incident waves to shallow angle waves.

12. The assembly of Claim 9, wherein a portion of the probe directly adjacent the substrate first surface includes a substantially elliptical cross-section.

13. The assembly of Claim 9, wherein a portion of the probe directly adjacent the substrate first surface includes an elongate channel.

14. The assembly of Claim 9, wherein a portion of the probe includes elongate cutouts that create a narrow edge of the probe, the edge lying directly adjacent the substrate first surface.

15. The assembly of Claim 9, wherein a portion of the probe directly adjacent the substrate first surface includes a roughened surface.

16. The assembly of Claim 9, wherein a portion of the probe directly adjacent the substrate first surface includes a plurality of bores.

17. An apparatus for cleaning a thin, flat substrate, the apparatus comprising:  
a support supporting the substrate in a generally horizontal orientation;  
means for applying a thin film of liquid to a first surface of the substrate; and  
a sonic energy transmitter; wherein  
the transmitter transmits sonic energy to the substrate first surface, and the transmitter attenuates the sonic energy to reduce the number of sonic waves that strike the substrate at or near a ninety-degree angle.

18. The apparatus of Claim 17, wherein the transmitter transmits sonic energy to the substrate first surface through the liquid.

19. The apparatus of Claim 17, wherein the substrate first surface is a top surface.

20. The apparatus of Claim 17, wherein the substrate is a semiconductor wafer.

21. The assembly of Claim 17, wherein the support is rotatable.

22. The apparatus of Claim 17, wherein the means for applying a thin film of liquid comprises a sprayer.

23. The apparatus of Claim 17, wherein the sonic energy transmitter comprises an elongate probe.

24. The apparatus of Claim 17, wherein the transmitter is formed of quartz, sapphire, silicon carbide, silicon nitride, quartz coated with silicon carbide or quartz coated with vitreous carbon.

25. The apparatus of Claim 17, further comprising a source of sonic energy coupled to the transmitter.

26. The apparatus of Claim 25, wherein the source of sonic energy is a transducer.

27. Apparatus for cleaning a thin article having at least a first substantially planar surface, the apparatus comprising:

- a support for the article;
  - a source of fluid for applying fluid to the first surface;
  - a transmitter configured to vibrate so as to transmit sonic energy through the fluid to the first surface to loosen particles on the first surface;
  - a transducer for vibrating the transmitter; and
  - a wall with an opening therein through which gas is introduced to flow in contact with the transducer; wherein
- the transmitter attenuates the sonic energy to reduce the number of sonic waves that strike the article at or near a ninety-degree angle.

28. The apparatus of Claim 27, wherein the article is supported in a substantially horizontal orientation.

29. The apparatus of Claim 27, wherein the article comprises a semiconductor wafer.

30. The apparatus of Claim 27, wherein the source of fluid comprises a sprayer.

31. The apparatus of Claim 27, wherein the wall forms a part of an enclosure, and the enclosure creates a space surrounding the transducer, and the opening introduces gas into the space.

32. The apparatus of Claim 31, wherein the gas purges the space.

33. The apparatus of Claim 31, wherein the gas cools the transducer.

34. A method of cleaning a thin, flat substrate, the method comprising the steps of:

- supporting a thin, flat substrate, the substrate having at least a first surface;
- applying a liquid to the first surface;
- providing at least a first source of sonic energy;

providing at least a first sonic energy transmitter spaced from the substrate but in contact with the liquid;

energizing the first source of sonic energy, thereby applying sonic energy to the transmitter;

transmitting sonic energy through the transmitter to the substrate first surface through the liquid; and

attenuating the sonic energy to reduce the number of sonic waves that strike the substrate at or near a ninety-degree angle.

35. The method of Claim 34, further comprising the step of supporting the substrate in a substantially horizontal orientation.

36. The method of Claim 34, further comprising the step of rotating the substrate as the liquid and sonic energy are applied to the substrate first surface.

37. The method of Claim 34, further comprising the step of spraying the liquid onto the substrate first surface.

38. The method of Claim 34, further comprising the step of reducing a ratio of normal-incident waves to shallow angle waves.